ILLANEOUS REPORT NO. 39
• OCTOBER 1955

Proceedings of the LAKE STATES . . . Aerial Brush Control Meeting and Tour

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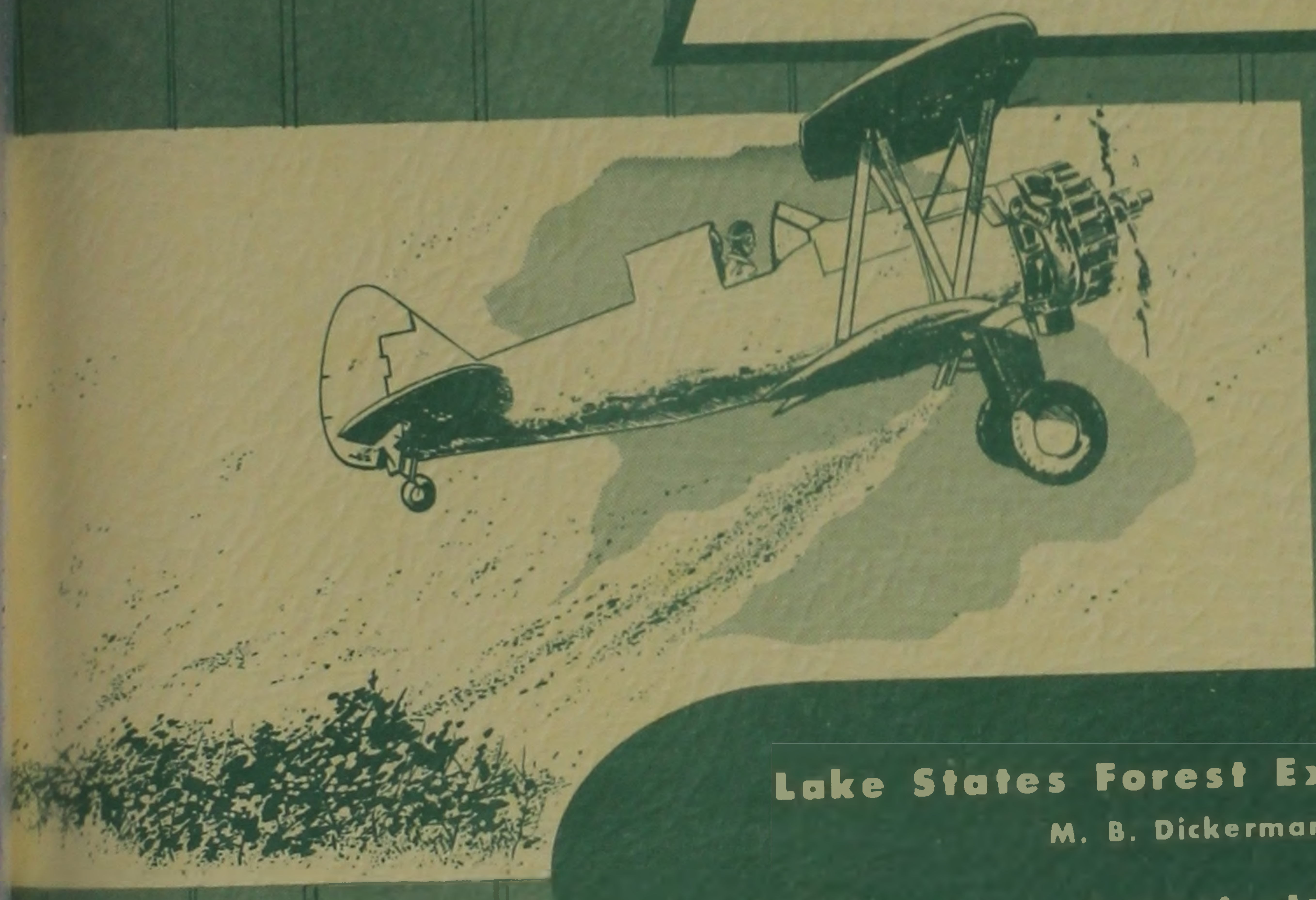
• July 26-28, 1955 •



Lake States Forest Experiment Station
M. B. Dickerman, Director

U.S. Department of Agriculture-FOREST SERVIC

FOREWORD

In 1953 the Lake States Forest Experiment Station and the Minnesota School of Forestry sponsored a meeting for foresters and chemical companies on the chemical control of woody plants. Since then a great deal of interest has developed on the use of aerial herbicide sprays for brush control; and a number of tests of their effectiveness have been made.

In response to the increasing interest on the subject, the Lake States Station arranged a 3-day meeting, July 26-28, 1955, in northeastern Minnesota to exchange information about aerial application of selective herbicides for forestry purposes and to observe the results of tests. One hundred foresters, aerial spray company operators, and chemical company representatives attended the meeting.

This report summarizes the formal papers and discussions to make them available to those who attended and to others who could not be present but have an interest in the subject. Descriptions of the sprayed areas visited on the 2-day tour are also presented.

This meeting was made possible only by the wholehearted cooperation of all those who were called upon to take part in the program. The willingness of all at the meeting to participate in the very fruitful exchange of ideas contributed greatly to its success.

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PROCEEDINGS OF THE

LAKE STATES AERIAL BRUSH CONTROL MEETING AND TOUR

JULY 26, 27, AND 28, 1955[2]

HERBICIDES USEFUL TO FORESTERS IN AERIAL BRUSH CONTROL

L. L. Coulter
Agricultural Chemical Development
The Dow Chemical Company, Midland, Michigan

Herbicides which are useful in aerial brush control must necessarily be effective in small quantities and must be adaptable to low-volume application. For this reason, the primary chemicals which lend themselves to this type of application are 2,4,5-T and 2,4-D. Other materials, of course, find uses in plantation management but are applied primarily by ground equipment. Since this is essentially an aerial conference, the discussion will not include the latter group of materials.

2,4,5-T and 2,4-D

2,4,5-T, which is the common name for 2,4,5-trichlorophenoxyacetic acid, and 2,4-D, which is the common name for 2,4-dichlorophenoxyacetic acid, exist in the unformulated state as whitish crystalline, relatively insoluble compounds. It is difficult for the man in the field to use these materials in this form, and so it is necessary that they be prepared in such a way that they can be easily handled. In order to do this and to obtain maximum efficiency from the compound, the chemist

1/ Maintained in cooperation with the University of Minnesota at St. Paul 1, Minnesota.

2/ Formal papers were presented the morning of July 26 in the High School Auditorium of Grand Rapids, Minnesota; discussions and demonstrations of equipment and aerial spraying techniques were held in the afternoon at the Grand Rapids airport; test areas were visited on July 27 and 28.

develops what is called a formulation. Starting out with 2,4,5-T acid, for example, the chemist reacts this material with an alcohol to form an oil-soluble chemical called an ester. This ester may be dissolved in an oil; however, it would be impossible to use this type of mixture in water in the field since, as we all know, oil and water do not mix readily. Therefore, an emulsifier is added which makes it possible to mix this oily formulation in water to form an emulsion, and it is identified by its white, milky appearance which most of you have seen. Each ester is identified with the alcohol which is used in its manufacture. For example, ethyl alcohol is used to manufacture the ethyl ester; butyl alcohol, the butyl ester; etc.

Early in the development of these materials, it was determined that the ester could volatilize and that the volatility products could injure adjacent plants. Esters of this type, which are classified as high-volatile esters, include ethyl, isopropyl, butyl, and amyl or pentyl. Subsequently, a research program was initiated to develop more efficient esters of low volatility. Some of the low-volatile esters developed include propylene glycol butyl ether and butoxy ethanol. This classification is recognized by manufacturers and users, and is based on standards set up by the United States Department of Agriculture. In an extensive research project conducted by our own organization, we found that there was a considerable range in activity of esters, and, while it was fairly easy to synthesize esters which were low-volatile in nature, they were not all necessarily as active as some of the standard esters. On the other hand, some exhibited activity considerably above that of isopropyl or butyl esters. In our work, the propylene glycol butyl ether ester was outstanding in activity.

Storage of Formulations

One of the aspects which the formulating chemists must consider in developing a formulation for field use is its storage properties. Up here in Minnesota where winter temperatures are relatively low, storage can be an important consideration. Some of the low-volatile esters have excellent storage properties. For example, the typical minimum safe storage temperature for our formulation of the propylene glycol butyl ether ester of 2,4,5-T is 0° F., while with the butyl ester formulation, the minimum safe storage temperature is around 20° F. The isopropyl ester of 2,4-D should not be stored below 32° F. If esters which tend to crystallize at low temperatures are stored below 32°, they should be brought inside prior to use, and after the temperature of the liquid is brought up to room temperature, the container and contents should be agitated thoroughly to make sure that all the material has been redissolved. It is often difficult to redissolve the esters, and the chemical should not be used until complete solution is assured. While information is available on storage temperatures for different esters,[1/] probably the best guide is to read the manufacturer's label carefully and follow his instructions regarding storage.

1/ Kelly, J. A., and Coulter, L. L. Storage of herbicides. Farm Chemicals 117: 8. Aug. 1954.

Oil-Water Emulsions

Some of you who are working with airplane application of herbicides may have run into difficulty due to the formation of a thick, white, mayonnaise-type mixture when combining ester formulations with oil and water. Since one of the standard airplane mixes of weed killers for spraying involves about 25 percent fuel oil or kerosene, it is important to follow certain rules in making a usable mixture. A standard emulsion is a mixture containing small particles of oil distributed through the water. Oftentimes, if the material is not mixed properly, a product which is called an invert emulsion develops, and this is the thick, mayonnaise-type mixture which can plug pipelines and nozzles. This can be avoided by first mixing the oil and the chemical formulation and then with agitation adding this mixture to the desired amount of water. The conditions which favor the development of the invert-type emulsion are rather demanding, and this emulsion may not always form. However, it is most likely to give trouble when the oil-chemical mixture is poured in the tank first and then a small amount of water is added with agitation.

Amine Salts of 2,4,5-T and 2,4-D

There is another form of 2,4-D and 2,4,5-T used commercially called the amine salt. Amine salt formulations are generally regarded as more selective than esters and are used extensively for weed control in crops. They have not been used to a large extent in woody-plant control. Although activity is good, amines are not as dependable and may form precipitates in hard water. As a result, the esters have come to be known as the standby for "heavy duty" woody-plant control. These amine materials are liquid formulations also and when added to water form a true solution. The amine gives a more or less clear spray solution following the addition to water while, as mentioned earlier, the ester forms a milky emulsion.

Herbicidal Action

I don't believe that the general activity and mode of action of these materials are covered in other parts of the program, and I would like to make a few generalizations. In the first place, these materials are regarded as synthetic growth substances or growth regulators in that they act in small quantities and when applied to one part of the plant have the facility of moving to and affecting another part of the plant. Their action is determined to a considerable extent by the condition or growth activity of the plant at the time of application. We find that, when herbaceous plants are sprayed during the early part of the summer after the leaves are fully developed and the stems are elongating rapidly, excellent control may be obtained, while applications made later in the summer after growth has slowed down and the plant is relatively dormant may not be as effective. It is important here to consider one other basic factor in the effectiveness of these chemicals.

It has been determined that the chemicals generally move with the food materials of the plant. Therefore, earlier in the spring when the leaves are expanding and drawing on other portions of the plant for reserve food materials to make new tissue, we find that there is less movement of the chemical through the plant. Application made at this time may burn the leaves but result in little final kill. However, after these leaves are fully developed and expanded, they begin to manufacture food materials in excess of the requirements for their growth and are able to move the chemical out into the other portions of the plant. Soil-moisture levels adequate for good growth are desirable for most efficient herbicidal action. Following the application of 2,4-D or 2,4,5-T, we note twisting of stems, and in many cases the stem or trunk may split. This splitting of the bark is due to the stimulation of the cells to the point where the bark casing is no longer able to retain the tissues inside which literally burst out. This action is not necessarily associated with a high degree of final control but is a good indication that the herbicide is working.

2,4,5-T Versus 2,4-D

Since there are two primary materials used in aerial applications, namely, 2,4-D and 2,4,5-T, it is important to consider where each of these materials should be used. Some of the earlier concepts held that 2,4-D was active on most plants and 2,4,5-T was active on some of the more resistant ones, so a mixture was used to control a wide range of species. However, it has been increasingly evident that there are many species of woody plants which do not respond to 2,4-D and few which 2,4,5-T does not affect. Generally speaking, 2,4,5-T will control most species which 2,4-D controls and will do a much better job on some of the species such as oak, maple, and ash. If you are spraying for the control of solid stands of aspen, alder, willow, or other species which are considered to be susceptible to 2,4-D, it makes sense, in general, to use 2,4-D alone. On the other hand, if you are spraying for control of maple or oak, or if you have a high proportion of maple and oak scattered through the stand, 2,4,5-T is probably the most effective material to use, and it will also take care of any scattered aspen, alder, or willow which happens to be growing in the area. One limitation to using 2,4-D alone, as we will see later on during this tour, is the problem of raspberry which may come in on some sites following the application of 2,4-D. 2,4-D has little effect on raspberry, and following the removal of suppressive cover such as alder or aspen, raspberry is liable to develop into quite a dense stand. 2,4,5-T will, of course, kill a high percentage of raspberry.

Kuron

One other material which has been used in test work to some extent in this area is Kuron, which contains a low-volatile ester of 2(2,4,5-trichlorophenoxy)propionic acid. This compound is variously referred to as Silvex or 2,4,5-TP, and while the common name of Silvex has been proposed, there is considerable confusion as to common names at the moment. Kuron is the trade name for one of two commercial emulsifiable formulations now available. It is the material which is highly effective on oaks. It is being used commercially in the southwest rangeland operations where the control of post and blackjack oaks is a primary problem. Here in the Lake States area, it has been used experimentally on mixed stands of brush, and while it has not been completely evaluated, it appears to be more selective than present materials and may possibly have an advantage for control of oak and maple in Minnesota. Thus, if the control of oak or maple with ground or aerial applications is an objective, Kuron is a material which should be considered.

Other Herbicides

There are a number of other materials coming down the line which may ultimately be used in plantation work. One of these is a grass-controlling material called dalapon (the common name for 2,2-dichloropropionic acid). This material is a systemic grass-killer in that the leaves pick up the chemical and move it to the growing point of the plant. It has shown some promise for suppression of grasses prior to planting of conifers. The development of this material for grass control in connection with conifer production will require considerable research since the material can and will injure conifers if improperly applied, and research will have to determine how the material can be used without causing injury.

One other material which has been used on an experimental basis in this area is aminotriazole. This is a relatively new herbicide now being developed by American Cyanamid Company and American Chemical Paint Company. I believe Dr. Melander of the American Chemical Paint Company is here and I have asked him to present a short summary of the present status of this material in the Lake States.

I appreciate the opportunity of meeting with this group today, and while I am sure I have not covered this subject completely, I hope that if any of you have any questions you will not hesitate to ask them this morning.

DISCUSSION

Coulter called upon L. W. Melander, American Chemical Paint Co., to discuss aminotriazole, a newly developed chemical herbicide. Dr. Melander said that: Aminotriazole is used as a defoliant for cotton plants and is known to prevent cotton sprouting. Its use is still largely in the experimental stage, but preliminary tests show that it kills poison ivy and wolfberry (Symphoricarpos occidentalis) very quickly. It has the peculiar property on many species of showing no effect the first season of application; the second season the leaves of the sprayed plant come out but are white; the third season the plants so affected are dead. It has been used on black oak, mockernut hickory, and white ash with good effect. Conifers sprayed with the chemical have put out white "candles" the second season, but it is too early to tell if they will be killed. No tests have been tried with aspen.

Following this short impromptu talk by Dr. Melander, the meeting was opened for questions.

Jenkins -- Are low-volatile esters that are recommended by the U. S. Department of Agriculture the more active ones?

Coulter -- The USDA approves a label indicating that the manufacturer has shown properly the contents of the container. It does not indicate the activity of the chemical therein.

Anon. -- How can a purchaser insure that he is getting a low-volatile, high-activity ester?

Melander -- The bid should specify the ester that is desired.

Burkett -- How do we know what is a low-volatile ester of high activity?

Coulter -- Most companies can make recommendations, but it is well to check with government or state research workers.

Melander -- Pick the chemical that, on the basis of past tests, gave good results.

Jenkins -- In mixed brush, would a 2:1 or 1:1 ratio of T to D be best?

Coulter -- Wherever it is logical to use a mixture of the two, T alone will be satisfactory.

Hubbard -- What is the difference in price between T and D? Isn't T higher?

Coulter -- The unit cost of T is higher, but the price per unit of mixed spray should be comparable or close together.

Burkett -- We are thinking of spraying herbicides along with insecticides on red pine. What is the earliest date that we could safely do that?

Arend -- In your area, no earlier than the 15th of July. August 1 probably would be better. Spraying should be done after the buds harden off.

EFFECTIVENESS OF CHEMICAL SPRAYS ON RESISTANT SPECIES

E. J. Jankowski, Chief Forester
The Northwest Paper Company

When I was asked to speak on the "Effectiveness of Chemical Sprays on Resistant Species" I felt like the man who was asked to discuss what happens when an irresistible force meets an immovable object. "Effectiveness of Chemical Sprays on Resistant Species!" According to the popular song, "something's gotta give," but in the case of a truly resistant species, what gives? However, there are degrees of resistance, and it is in this regard that I am to discuss aerial sprays.

When we say a species is resistant to aerial sprays, we mean that the species is not, or is only slightly, affected by the application of sprays commonly used as herbicides.

Factors Affecting Resistance

There are a number of factors which affect the resistance of a plant or species to a chemical spray. These factors must be defined in any discussion of the comparative or relative resistance of species.

The first important factor is the type of spray being used. Aspen, for example, seems more susceptible to 2,4,5-T than to 2,4-D. In some instances species may even show variations in resistance to different brands of the same chemical. With the numerous new chemicals constantly being developed, it is important, when speaking of resistance of species, that reference be made to the type and manufacturer of the chemical being considered. In this discussion, resistance is related to the use of a 50-50 mixture of 2,4-D and 2,4,5-T commonly used in aerial-spray work.

A second equally important factor having an effect upon resistance is the amount of chemical applied per unit of area. Aspen, for example, might well resist an application of 1 pound of the above-mentioned acid per acre but might easily succumb to the application of 4 pounds. Present practice is to use from 1 to 2 pounds per acre in aerial-spray work.

Another factor having an effect upon the resistance of a species to chemical sprays is the season of year the application is made. Even spruce, one of our most chemically tolerant species, is susceptible to sprays in the early spring before the new growth has had a chance to harden.

A fourth factor influencing resistance is the age of the plant being treated. Aspen suckers are much more easily killed than are older aspen trees. Generally speaking, younger trees of any species are less resistant than older trees.

Plant vigor, no doubt, has an effect on resistance. Trees weakened by suppression, insects, diseases, etc., appear to be much more easily killed by sprays than vigorous stems. Excellent results were obtained with the application of 1 pound of acid per acre to a sapling stand of aspen which had been weakened by several attacks of the forest tent caterpillar.

A sixth factor affecting the resistance of a species may be the kind of diluent used. I personally have not noted any significant difference in the use of diesel oil, water, or an emulsion on the resistance of woody plants to chemical sprays. However, detailed studies may well show that the type of diluent used does have some effect upon resistance.

The amount of diluent applied per acre may also prove to be a factor worthy of consideration. For example, 1 gallon of diesel oil per pound of acid per acre may not produce the same results as the use of 5 gallons of diesel oil per pound of acid per acre. General observations indicate that if a difference does exist, it is not appreciable.

An eighth factor to be considered is that of weather. Just what effect, if any, the weather plays in the susceptibility of plants to herbicides has not yet been shown, but a definite relationship may exist.

Finally, the method of application must have some bearing on the effectiveness of herbicides. Airplane sprays may not be as effective as helicopter sprays. The size of spray droplets may also prove very important.

Relative Resistance of Species

When we say a species is resistant, we should really state the conditions under which it is resistant--type and amount of chemical used, type and quantity of diluent used, age of plants, season sprayed, etc. Because of the many variables mentioned, it is very difficult to classify species as to their relative resistance without constantly making exceptions. More information gathered from controlled experiments

must be obtained before any accurate classification can be made. That much confusion exists regarding the relative resistance of species to herbicides is exemplified by the susceptible species listed on the labels of most of our popular brands of chemicals. Aspen, for example, offers no problem, according to the labels. Nor, for that matter, does pine! You can imagine my chagrin when I discovered the chemical I had just applied to release one of our pine plantations was advertised as being "a most effective formulation for controlling pine."

Despite its limitations, I have made an effort to classify into three broad categories the relative resistance of some of the common woody plants to aerial application of 2,4-D; 2,4,5-T mixtures.

High resistance	Moderate resistance	Low resistance
Spruce	Jack pine	Paper birch
Balsam fir	Maple	Oak
Cedar	Aspen	Hazel
White pine	Chokecherry	Alder
Norway pine	Thimbleberry	Willow
Balsam poplar	Elm	Raspberry
Tamarack	Ash	Pin cherry
		Blueberry
		Sweetfern
		Rose
		New Jersey tea

Species of High Resistance

It will be noted that all the common coniferous species except jack pine are considered as having a high resistance to the herbicide. To the usual application of from 1 to 2 pounds of acid per acre, these highly resistant species show little or no adverse effects. To higher concentrations, some contortion of needles and/or current growth does occur. No doubt a very highly concentrated solution would kill even these relatively resistant species.

It will be noted that balsam poplar is included in the list of highly resistant species. It is probable that the maples should also be listed in this category. Balsam poplar and maple seem able to withstand normal concentrations of spray without appreciable ill effects.

Species of Moderate Resistance

Jack pine seems to be the only conifer lacking high resistance to aerial sprays. Jack pine is capable of tolerating about 1 pound of D-T acid per acre without damage; $1\frac{1}{2}$ pounds will cause dying of the current year's needles; 2 pounds would likely kill the tree.

Much attention has been given to the resistance of aspen to chemical sprays. Eugene Roe indicates in a paper published last March[1/] that good results generally have not been obtained in the chemical control of aspen. In general, I would agree with Mr. Roe although my personal experience with aspen is that it is not a particularly difficult species to kill--usually 1½ pounds of D-T acid have proved quite effective. Older stands may require heavier concentrations.

The moderately resistant species react to herbicides by a deformity and discoloration of leaves and partial dieback. Partially damaged trees continued to survive for a number of years before finally dying or resuming normal growth, depending upon the severity of injury.

Species of Low Resistance

Most of the common brush species, oak, and paper birch fall into the category of highly susceptible species. These species are usually killed by a single application of from 1 to 2 pounds of acid per acre. In the case of oaks, several months may elapse before any evidence of injury is noted, but a 90-percent dieback can usually be expected.

Injury from aerial sprays appears to be confined to the aerial portions of woody plants. In virtually all instances, sprouting can be expected to occur, after spray injury, in species which normally reproduce by sprouting.

Conclusion

In conclusion, I might emphasize that aerial spraying is a relatively new silvicultural tool and should be used as such by the forester in the field. Much research is needed before the application of these powerful herbicides becomes an exact science. Properly developed, aerial spraying may become the most valuable silvicultural tool since the invention of the axe and saw.

1/ Roe, Eugene I. Aerial brush control in Lake States Forests. Lake States Forest Expt. Sta. Misc. Rept. 37, 9 pp., March 1955. (Processed.)

DISCUSSION

Burkett -- What is the effect of Kuron on sprouting of oak?

Jankowski -- We have obtained a good kill from spraying Kuron last year, but it is still too soon to know the results on sprouting of oak. Oak sprouts from the root crown.

Ennis -- Was the 3-percent mortality of jack pine due to the effects of spraying?

Jankowski -- Yes, this mortality was due to the spraying. The jack pine turned orange 3 weeks after spraying, but no effect was noticeable on the oak. The jack pine eventually recovers, but the next year the oak is dead.

Jacobs -- What is the effect of spraying on white pine?

Jankowski -- White pine is very resistant, more so than jack pine, although occasional individuals are injured.

Hubbard -- What time of year did spraying give 3-percent mortality of jack pine?

Jankowski -- The end of July and early August.

Coulter -- We have found that $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds of acid per acre give only a partial kill of aspen.

Jankowski -- We have obtained good results with as low as 1 pound, but heavier concentrations give better results.

Coulter -- Do you get resprouting from large trees 8 or 10 inches in diameter?

Jankowski -- Much of our work with aspen has been on young sprouts which arose after machine planting. These have been killed successfully, but we have had some sprouting from larger aspen.

Knox -- Do you use an oil or water spray?

Jankowski -- We have used both: $1\frac{1}{2}$ pounds an acre in 2 gallons of oil or in 4 gallons of emulsion per acre.

Knox -- What is the smallest amount you use?

Jankowski -- One pound per acre.

Burkett -- What herbicide do you use with this low rate of application?

Jankowski -- We generally use a 1:1 mixture of T and D in oil; 1½ pounds of acid per acre in 2 gallons of oil.

Melander -- Do you notice any difference between oil and water sprays on the conifers?

Jankowski -- I have noticed no difference in the damage to conifers.

Mackie -- Have you any experience with spraying in the rain?

Jankowski -- I have found that rain makes no difference, even if the leaves are so wet that the water is dripping off them.

Hubbard -- Are 1½ pounds per acre often used?

Adams -- The State Conservation Department used that rate for its spraying.

Fjosling -- We have equipment which can apply as little as ½ gallon of spray per acre.

Jankowski -- In our spraying, the same amount of acid in 2, 4, and 8 gallons of spray per acre gave similar results.

CHANGES IN PLANT COMMUNITIES FOLLOWING SPRAYING, AND RELEASE EFFECTS ON CONIFERS

H. L. Hansen
School of Forestry, University of Minnesota

The Problem

It is common knowledge to most foresters that brush constitutes one of the most serious obstacles to sustained-yield forestry in the Lake States. Recent statistics indicate that the acreage classified as grass and upland brush in northern Minnesota is increasing at a shocking rate, while the acreage in valuable pine types is correspondingly decreasing. This strongly suggests that our pine lands are in the process of reverting to brush. Reasons for this undesirable trend are several and will not be discussed here.

It is the purpose of this report to consider the possibilities of herbicides in preventing this reversion of pine to brush types. More specifically, an attempt will be made to relate the changes in

vegetation which have taken place during an 8-year period on some actual plots which were sprayed for the purpose of aiding in the establishment of pine regeneration.

What Was Done

In 1948 an attempt was started to get some of the information related to the general problem of brush as an obstacle to pine regeneration. Spraying was done on plots at Itasca State Park on July 24. The area chosen for the tests had a sprinkling of old-growth red and white pine seed trees within an easy seeding range so that, at least in good seed years, an adequate supply of seed was available and was not the limiting factor. Also present was a thin second story of aspen, paper birch, red maple, bur oak, and other minor species. The shrub stratum consisted of a dense stand of hazel, including both the common and the beaked species, with arrowwood, blackhaw, raspberry, chokecherry, honeysuckle, bush honeysuckle, panicled dogwood, and other species in minor proportion. The herbaceous ground cover was dominated primarily by wild sarsaparilla, bracken fern, large-leaf aster, grasses, and sedges. Some white pine regeneration was present (4,500 per acre on the control plots and 3,000 on the spray plots). However, only a few had lived long enough to reach 6 inches in height (375 on the spray plot area and 250 on the control plots). It was obvious that something--presumably the brush--was preventing the permanent establishment of the white pine seedlings.

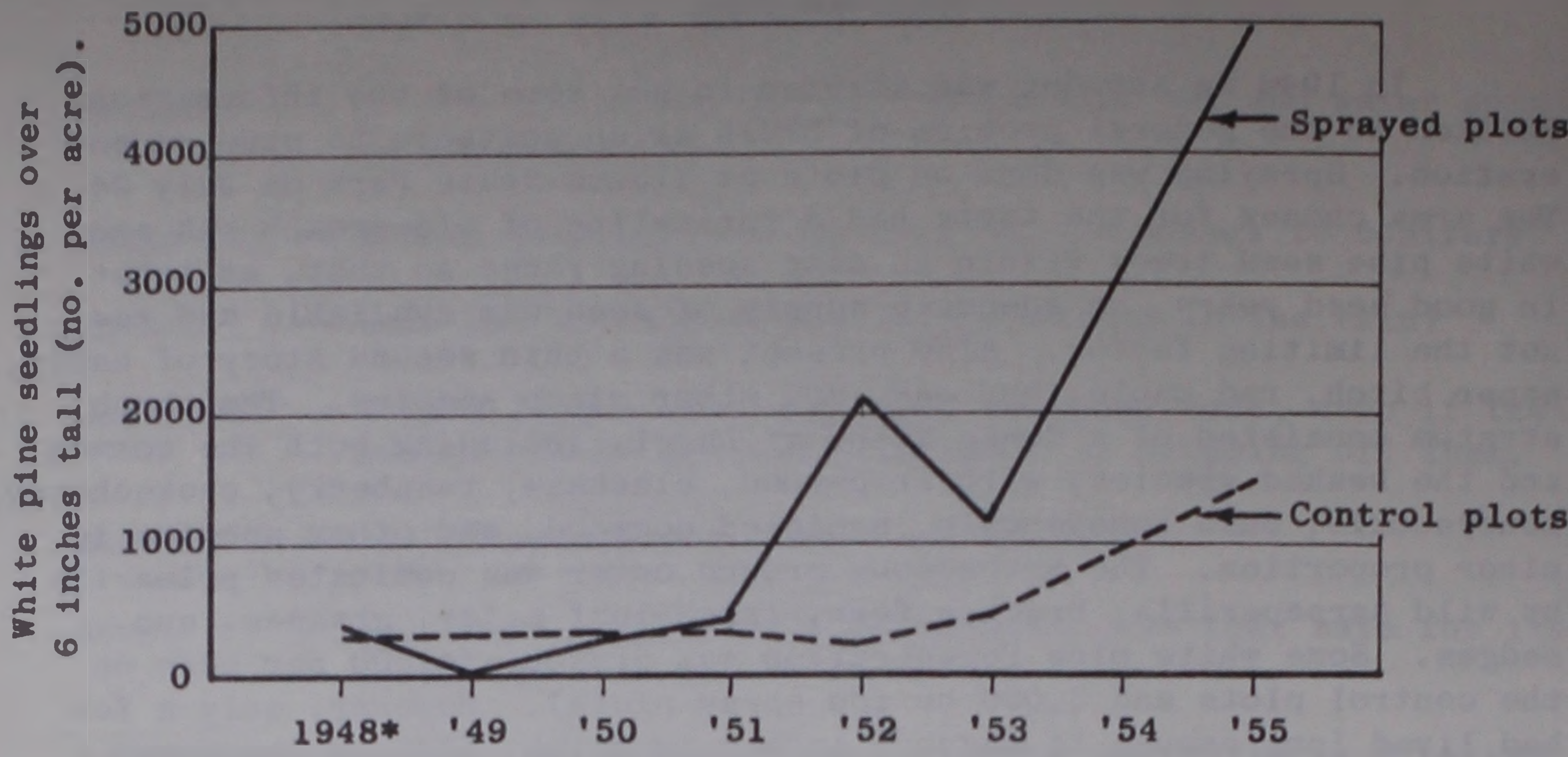
To test the hypothesis that reducing the brush density by an herbicidal spray would aid in the establishment of pine regeneration under such conditions, 2 plots--each 1/10 acre in size plus a 10-foot border--were sprayed, using an ethyl ester form of 2,4-D at the per-acre rate of 6 pounds of acid equivalent in 100 gallons of water. In addition, 2 similar control plots were set aside. Sixteen milacre plots were staked out to serve as permanent plots. On these, detailed records were kept of all tree and brush species and of the abundance of a number of the dominant herbaceous species including grasses and sedges. Annual vegetational checks were made each year since then except in 1954. This makes an 8-year span of detailed records.

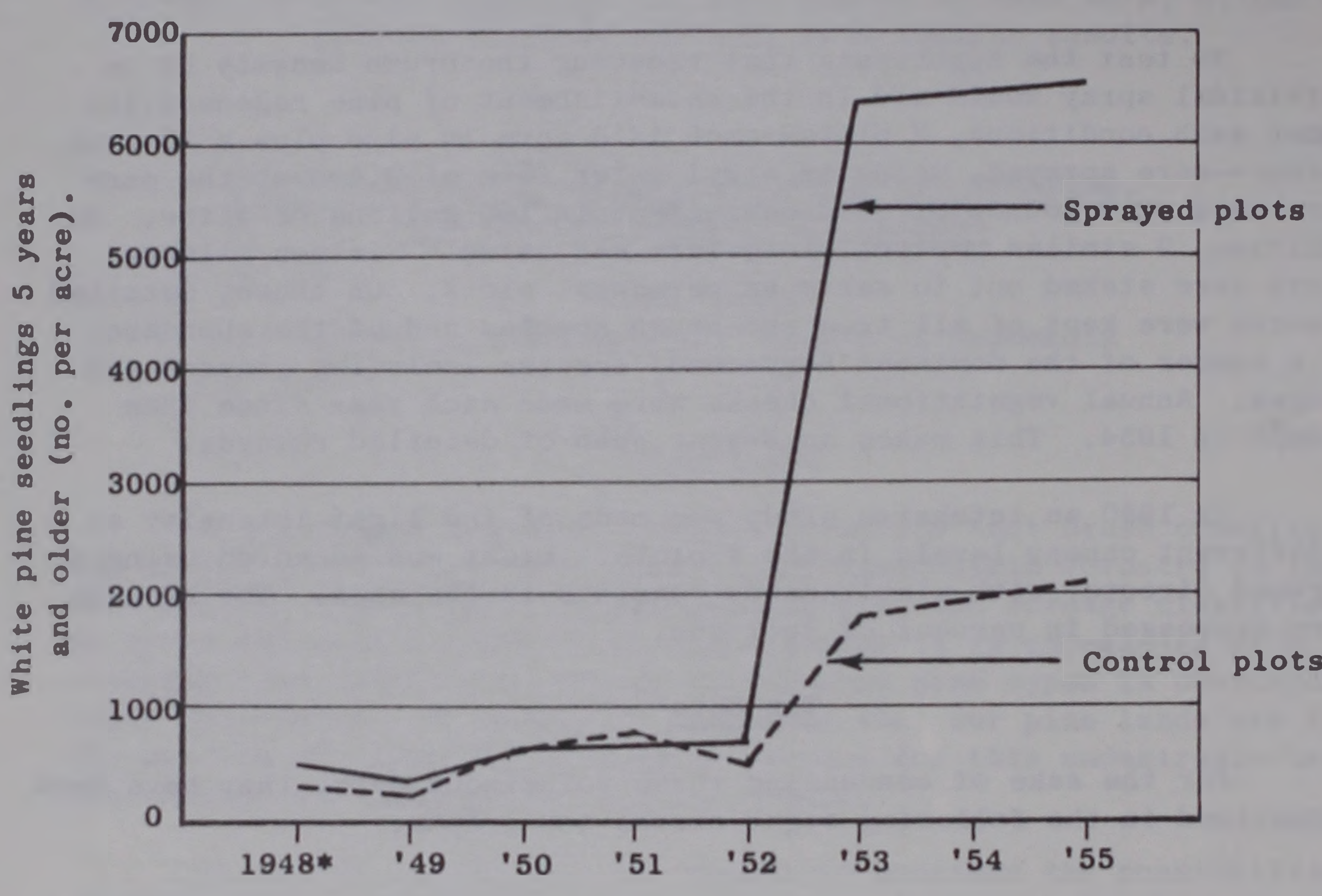
In 1950 an intensive study was made of the light intensity at 3 different canopy levels in the 4 plots. Light was measured using a Norwood director with simultaneous readings in the open. The results were expressed in percent of full sun.

The Data

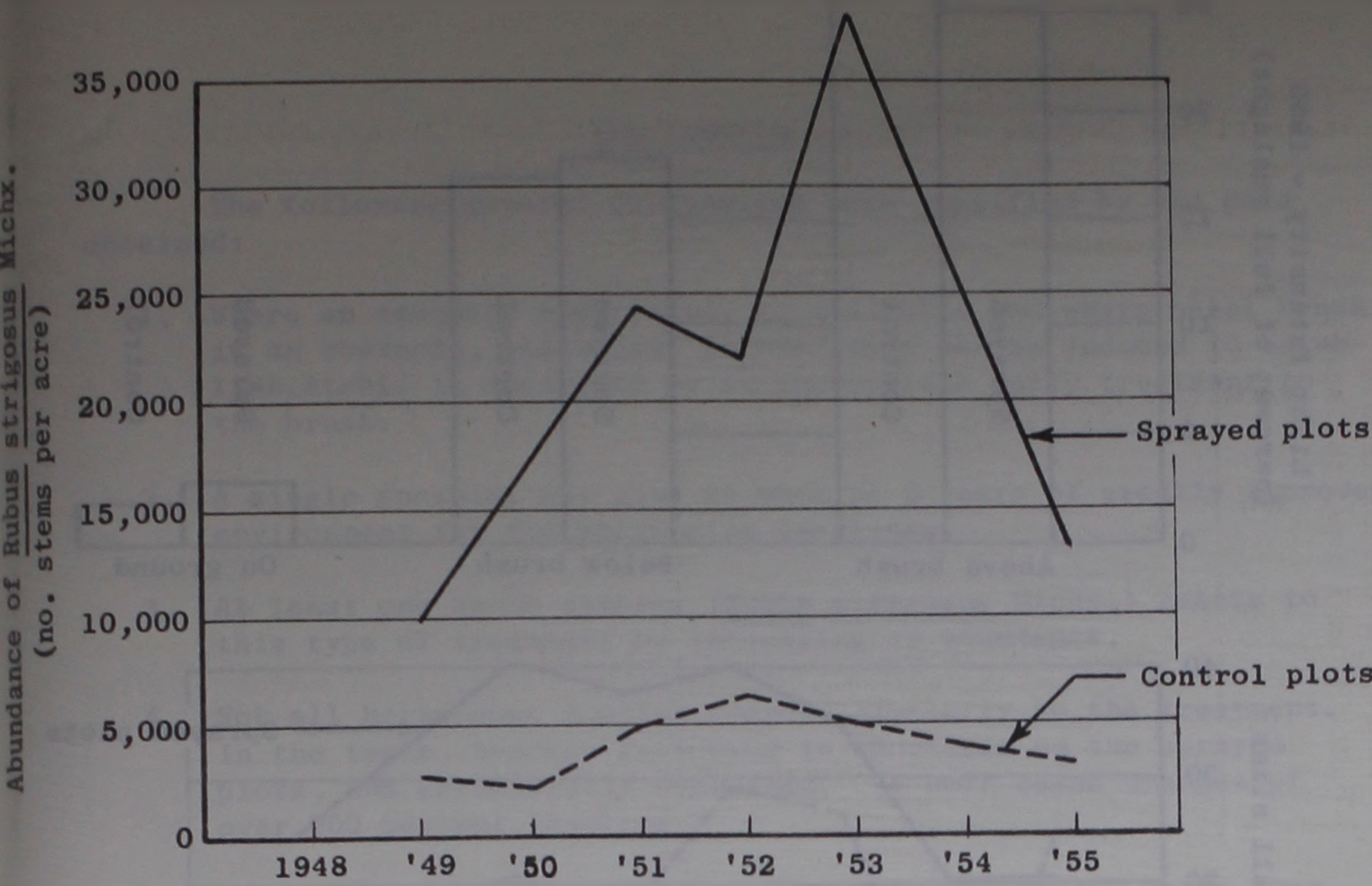
For the sake of condensing these voluminous data, they have been summarized in the following eight curves and graphs:

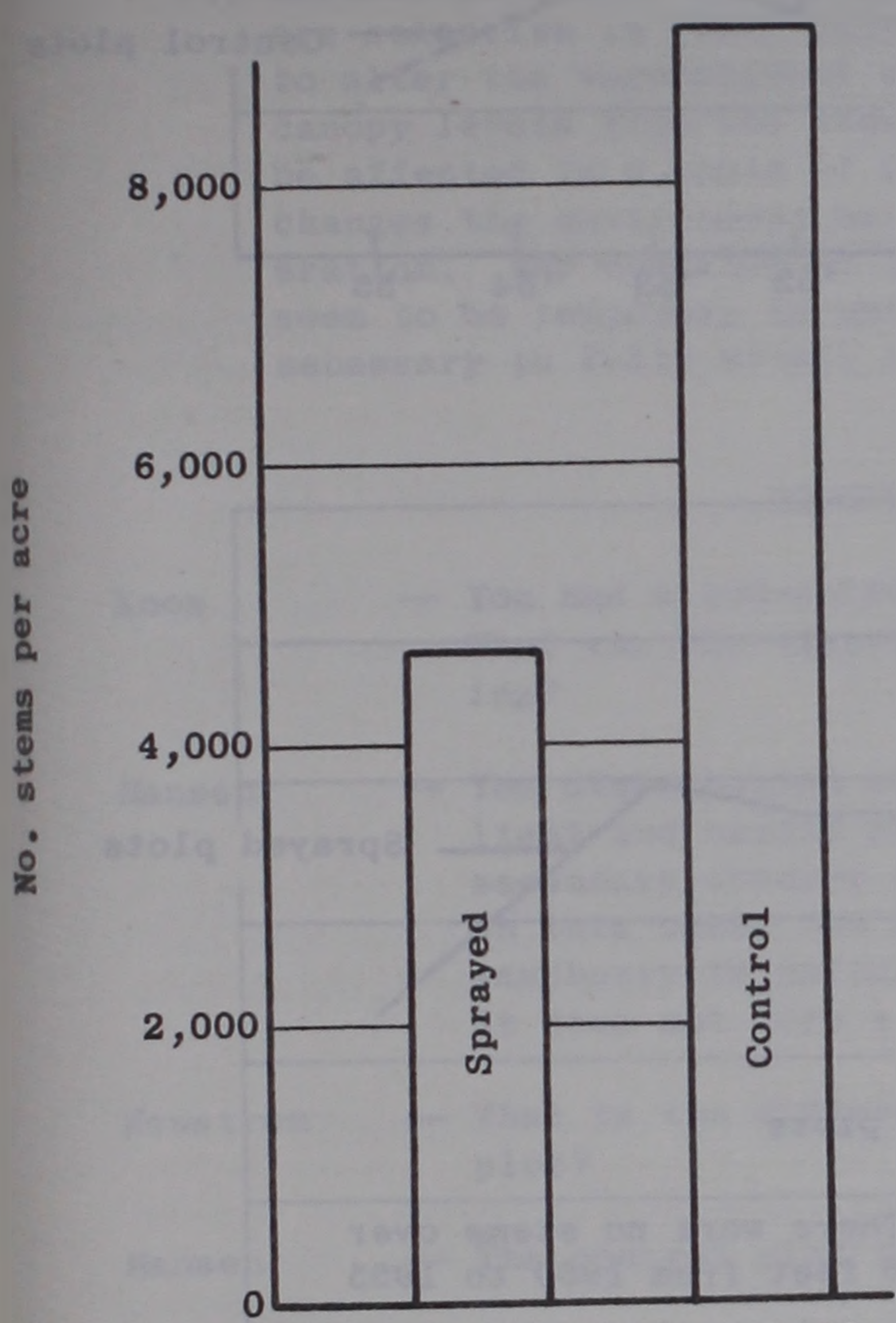
Vegetational Changes During an 8-Year Period After Spraying with 2,4-D. Data from plots at Itasca State Park



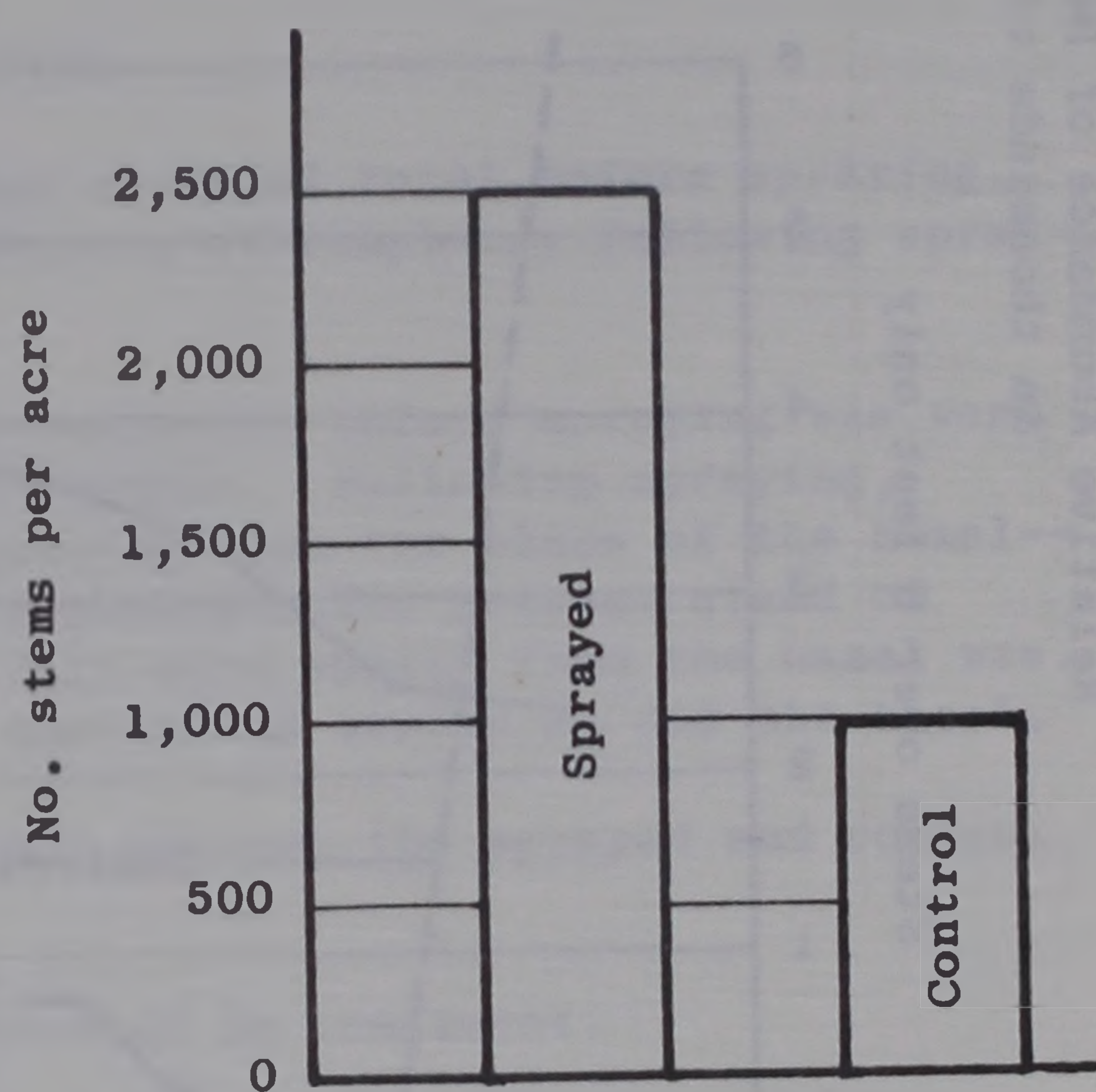


*1948 data taken just prior to spraying.

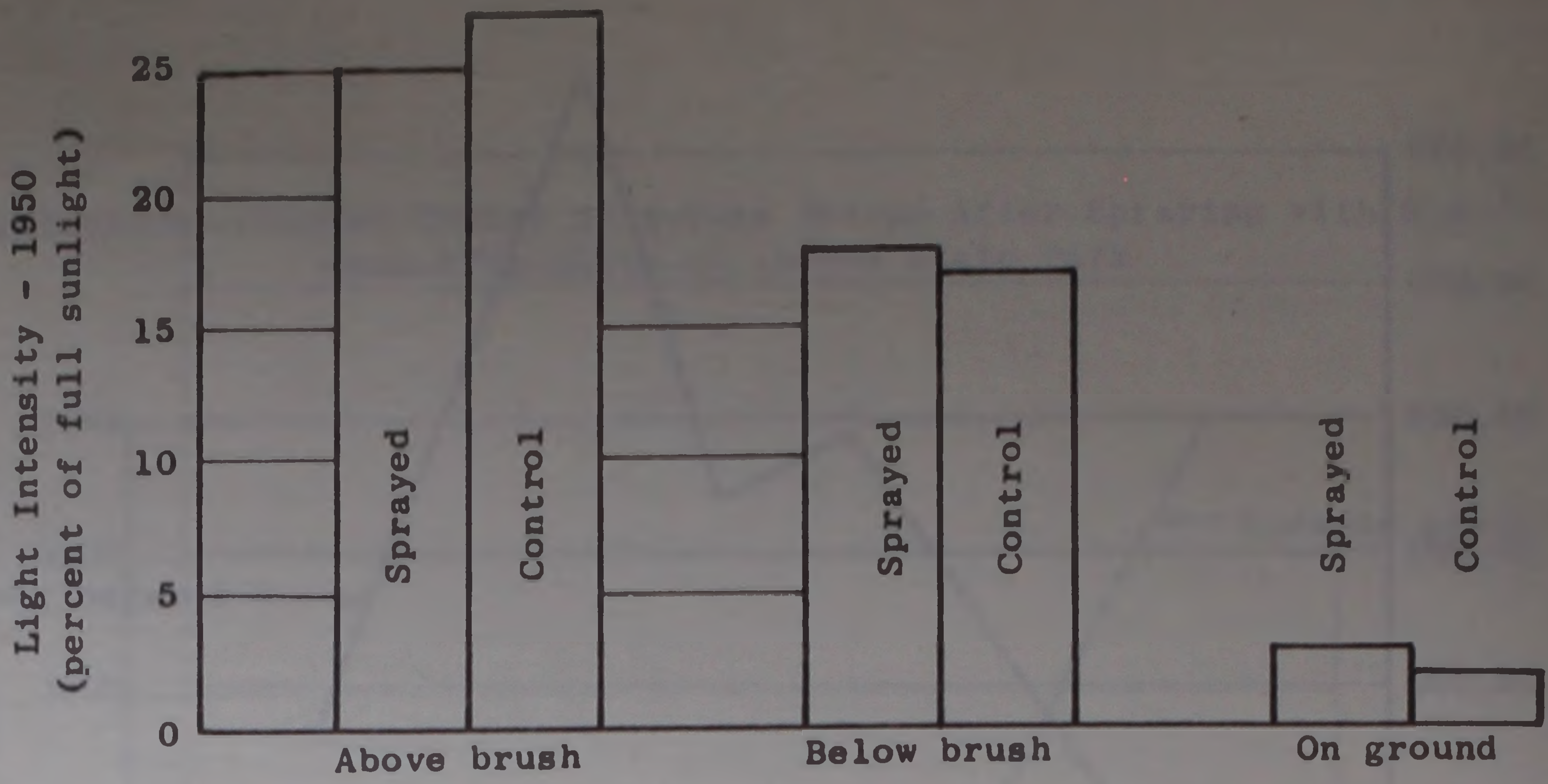




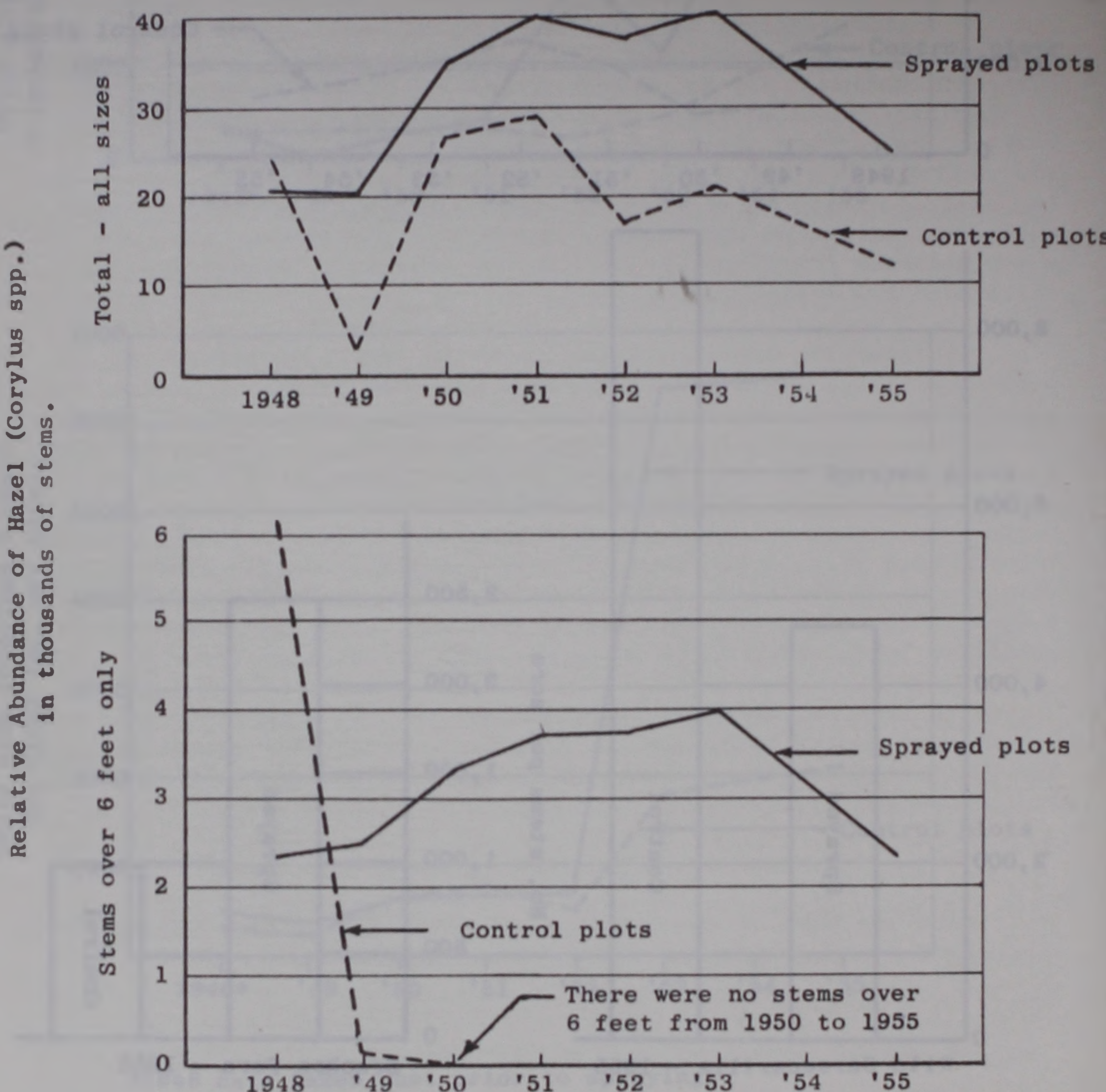
Wild Sarsaparilla - 1955



Bracken Fern - 1955



Light Intensity - 1950
(percent of full sunlight)
25
20
15
10
5
0
Sprayed
Control
Sprayed
Control
Sprayed
Control
Above brush
Below brush
On ground



Relative Abundance of Hazel (Corylus spp.)
in thousands of stems.
Total - all sizes
40
30
20
10
0
Sprayed plots
Control plots
1948
'49
'50
'51
'52
'53
'54
'55
Stems over 6 feet only
6
5
4
3
2
1
0
Sprayed plots
Control plots
There were no stems over
6 feet from 1950 to 1955
1948
'49
'50
'51
'52
'53
'54
'55

The Results

The following general conclusions seem justified by the data obtained:

1. Where an adequate seed supply is available and where hazel brush is an obstacle, white pine regeneration can be induced to establish itself in abundance by an appropriate spray treatment to the brush.

2. A single spraying may give as much as 8 years of greatly improved environment for the white pine seedlings.

3. At least one brush species (Rubus strigosus Michx.) reacts to this type of treatment by increasing in abundance.

4. Not all herbaceous species respond similarly to the treatment. In the tests, bracken increased in abundance on the sprayed plots, and sarsaparilla decreased. In both cases changes of over 200 percent resulted.

5. Herbicidal sprays of the sort used in these tests, since they are selective in their effects on different plant species, tend to alter the vegetational composition of forest stands. All canopy levels from the trees to the herbaceous ground cover may be affected in a chain of reaction. As a result of these changes the environment may be improved for coniferous regeneration. The duration of these changes is not known, but they seem to be temporary in nature. Repeated sprayings may be necessary to fully attain the objective of pine regeneration.

DISCUSSION

Knox -- You had a 100-percent cover of hazel before spraying. What was the distribution of raspberry following spraying?

Hansen -- The distribution of raspberry before spraying was very light and hardly noticeable. Following spraying, secondary species quickly took the place of the hazel--in this case, the raspberry. The present stand of raspberry is definitely more spotty than the hazel was. It does not form a continuous canopy as did the hazel.

Newstrom -- What is the difference between the sprayed and control plot?

Hansen -- The control plot received no treatment.

Sandberg -- Spraying will bring about a rapid change in succession, often a regression, so that unless release is rapid other species may occupy the area and present a problem worse than the original brush.

Hansen -- Yes, nature abhors a vacuum, so to speak. Some species will come in very rapidly after spraying to occupy the area. It is desirable to know in advance, by small-scale studies, what we may expect before undertaking spraying on a large scale.

Argetsinger -- We spray hazel to get balsam release. In 2 months following July spraying we have a change in species. Species present in small numbers before spraying will multiply rapidly in a short time.

Hansen -- Yes, the species that multiply rapidly following spraying generally were present on the area before spraying.

Michal -- What are the relative sizes of the trees on the two plots? Have you produced an overstocked stand by spraying?

Hansen -- On the sprayed plot the average height is 5 inches; on the control plot 4½ inches. The relatively small difference in average height of all seedlings is because of the large number of 2-year seedlings on both plots.

Michal -- What will we have in 10 years?

Hansen -- On the sprayed plot we will probably have a large number of pine over 2 feet tall; on the control plot a very few pine over 2 feet tall.

Melander -- Do you have any data on blister rust in the stand?

Hansen -- No data on rust in 1954, although looking at the plots, there were probably several thousand pines per acre infected by blister rust.

Woollett -- Can mistletoe on black spruce be controlled by herbicide sprays?

Roe -- Canadian experiments have shown that mistletoe can be controlled by herbicides, but I know of no work in this country.

Anon. -- What about liability in spraying berry patches?

Burkett -- When we are to spray areas with wild berries, we put out advance notice so that people will know that they need not look for berries in an area for several years following the spraying.

ELEMENTS OF A SATISFACTORY CONTRACT FOR HERBICIDE SPRAYING

Earl J. Adams
Minnesota Division of Forestry

1. Provision requiring that both plane and operator be properly licensed under laws of Minnesota.

    a. To do work in State, the operator must be licensed for aerial spraying.

    b. License indicates plane satisfactory--special requirements must be written in.

2. Requirement for workmen's compensation insurance and furnish proof of same.

3. Provision exempting the agency from claim for any damage, including injury to the pilot or damage to the plane resulting from services performed.

4. Statement as to supplies to be furnished by each, i.e., spray materials to be furnished by the agency.

5. Description of the area to be sprayed, including acreage.

6. Statement regarding the rate of application.

    a. Rate of application in gallons per acre.

    b. Responsibility of operator for proper application and provision for respraying.

    c. Agreement as to method of application, i.e., height of plane.

7. Statement as to who is to direct the spraying operation and to designate the time of spraying.

8. Statement as to responsibilities in marking the tract.

9. Rate of pay should be clearly defined.

EQUIPMENT AND TECHNIQUES FOR AERIAL SPRAYING

The afternoon session was held at the Grand Rapids airport where Gordon Newstrom, Mesaba Aviation Co., made his hangar available. No formal papers were prepared for presentation but a record was made of the meeting as it progressed.

Mixing Equipment

Sump Pump in Barrel

N. Powers of Mesaba Aviation Co. demonstrated a sump pump which is used in conjunction with 55-gallon drums to mix the spray and load the material into the plane's tank. The standard switch on an electrical sump pump had been reversed so that the pump operated when a string was pulled and stopped when the string was released. This equipment allows one man to fill the airplane by attaching a long string to the switch, enabling him to turn the pump on and off from where the plane is parked. The pump shown delivered 55 gallons in 6 minutes. It can be used in mixing the herbicide by directing the output of the hose back into the barrel. The importance of mixing the herbicide and filling the plane rapidly was stressed because of both the limited amount of suitable flying time in a day and the small number of days in a season when spraying is effective.

Home-Made Mixer

D. Sandberg of Kimberly-Clark of Minnesota, Inc. described a home-made mixer which utilizes a ½-inch d.c. drill with a small agitator on the end of a rod. A 1500-watt, gasoline-powered light plant is used to power both the drill and an electric pump for transferring the water to the mixing barrel and the spray into the plane. Sandberg prefers to have his own mixing and pumping equipment so that spraying may be done on short notice. Light-weight, portable equipment which will do the job quickly is needed. Since float planes are used by Kimberly-Clark, water for spraying is always available.

Loading Equipment

Portable Gasoline Pump

M. O. Manuel, Triangle Aviation Co., exhibited a small pump which can be truck-mounted or portable. It is powered by a standard 1-cylinder gasoline motor and pumps 24 gallons per minute. The planes he uses have a capacity of 60 gallons, so this pump fills the tank in less than 3 minutes.

Tank Truck

N. Powers showed a tank truck which is used for mixing, transporting, and loading chemical solutions. There were three separate compartments in the tank of 200-, 250-, and 300-gallon capacity. One compartment is used for the chemical, another for water or oil, and the third serves as a mixing tank. The pump stationed on the truck is used to circulate the mixture and mix the chemicals and carrier. In response to a question by Robb, Powers said that a solution is not allowed to stand for longer than one-half hour before it is remixed. Manuel pointed out that in most spray planes mixing continues in flight as the pump, driven by a fan turned by the airstream, circulates the mixture through a by-pass. Hence, the solution is under constant agitation.

Planes, Tanks, Booms, and Nozzles

Eldon Sorenson, spraying equipment manufacturer, opened the discussion in this portion of the program. The manufacturers and operators of aerial-spray equipment have to comply both with natural physical laws and with the regulations of the CAA. For this region, small airplanes have proved to be the best. They are easy to own, maintain, and operate. The engines used are dependable, reducing the down time which is expensive. Many small engines will run 1,000 to 1,500 hours between overhauls. Generally, equipment must be depreciated rapidly, which gives the small, low-cost plane an advantage. Spraying equipment, like the planes, must be dependable and trouble-free. Units with low weight and low drag are needed to keep performance of the plane high. Equipment is being manufactured which allows application of from 2 quarts to 5 gallons per acre.

Following this presentation, a number of questions were raised:

Burkett -- What is the best type of nozzle to use in aerial spraying?

Manuel -- There is no one best type of nozzle, but different types of nozzles must be used for different types of spraying.

Melander -- Is wear of the orifice of nozzles an important consideration?

Manuel -- Wear is important in the commonly used type of nozzle, which has a whirling plate. There is also some abrasive action on the orifice. Generally, after 1,500 gallons have been sprayed from a nozzle, sufficient wear has occurred to require replacement.

Burkett -- Is the spray application adjusted by adjusting the nozzle or by pressure of the spray system?

Manuel -- The amount of spray per acre depends on the ground speed of the airplane because the nozzles and pressure used are constant. However, the nozzles may be changed to give a different volume per acre or a different droplet size. One type of nozzle which is widely used has a diaphragm which opens at 10 pounds pressure or over. This type of nozzle is very good, for it allows a positive shutoff at the end of the field which prevents unintentional spraying.

Sorenson -- Atomizing nozzles are not used in aerial work because of the excessive drift and evaporation losses with fine sprays.

Hansen -- What kind of screening do you use?

Manuel -- We have strainers just ahead of the pump and in the nozzles.

Robb -- How wide a swath does the Piper standing on the apron spray?

Manuel -- At a height of 50 feet, with the 27-foot boom, we spray an 85-foot swath. At 100 feet, we spray a 100-foot swath. However, the drift problem becomes critical at 50 feet or higher.

Ralston -- What are the methods of paying for spraying--by the gallon, acre, or hour?

Manuel -- Generally, spraying is done on an acre basis. We spray peas at $2 per acre because of the small size of the fields. Larger tracts of forest lands cost about $1 per acre. In spraying thistle in pea fields where we spray only patches of the field, we charge $35 per hour.

Berklund -- Who assumes liability due to drift damage?

Manuel -- The sprayer works for the farmer as his employee, and the liability is the farmer's. In a recent case against a spray applicator in the State of Washington, it was decided that it was the farmer's liability, not the airplane operator's.

Burkett -- What should be the specifications for nozzles in contracts?

Manuel -- Nozzles should be used with a positive shutoff at each nozzle, either a diaphragm or a ball check. The diaphragm type is probably the best.

Adams -- Does the licensing by the State Department of Aeronautics require special nozzles?

Manuel -- No, the licensing covers the pilot and his safety equipment.

Adams -- The State Entomologist also enters into the licensing?

Manuel -- Yes, the Entomologist sees to it that the pilot and operator are competent. A short course is given each year at the University of Minnesota to train operators and pilots in spraying.

Arend -- Are spray planes licensed as experimental planes?

Manuel -- Spray planes have a restricted license which permits overloading but allows no passengers to be carried.

Robb -- Do aerial spray planes have special dispensation from the regulations concerning landing patterns?

Manuel -- No, but we do attempt to fly when others are not using the airport and can often disregard regular flight regulations. However, we take every precaution within reason for safe operation.

Jacobs -- Is pilot fatigue an important factor in operation?

Manuel -- Fatigue is very important; it is probably the largest single cause of accidents. We generally spray in early morning and late afternoon. Pilots must take some sleep in the day between these two working periods and at night also.

Jenkins -- We have an area of 300 acres to be sprayed which is located 20 miles from the landing strip. What size plane would be best to use in this situation?

Manuel -- There is probably no best size. All planes would have advantages and disadvantages in this situation. We prefer a small plane even for the stated condition.

Jacobs -- What length runway do you need for your planes?

Manuel -- Our planes take off after a 1,000-foot run; we like the runway to be 1,500 feet long.

Newstrom -- A float plane needs a lake long enough to enable the plane to safely clear the trees which surround the lake. We prefer a lake which permits a run of 2 or 2½ miles.

Sandberg -- We have had pilots flying from a 3/4-mile-long lake, but they encountered difficulties with this small a lake.

Newstrom then discussed the importance of getting an operator who realized the necessity of safety precautions. Planes must be licensed by the CAA so that, mechanically, all planes are in good condition. Shoulder harness and safety helmet should be compulsory equipment in aerial spraying. Many lives have been saved by harness and helmets. He told about an inexperienced but properly equipped pilot who was uninjured even though his plane was very severely damaged in a crash.

Marking the Area to be Sprayed and the Effect of Flight Patterns

Stanley B. Olson, Superior National Forest, discussed the marking of the spray area and the effect of flight patterns.

Ground marking is definitely a problem and adds to the cost of spraying. Proper marking of the area is necessary if the pilot is to do the best possible job.

Flags are probably first thought of when marking an area, but they have the disadvantage of not being too easily visible in the still air needed for spraying. They are also somewhat difficult to get up high enough on a pole or on a tree. Bamboo frames to hold the flag out from the pole have been used to make the flag more visible. Flags can be set up to mark the area several days ahead of flying, which is an important advantage.

Neoprene balloons are especially liked by pilots, for they can be placed high above the trees and are seen well from all angles. Three sizes of balloons were shown. Helium-oxygen mixtures (80-20) are used to fill the balloons; pure helium can be used but is thought to escape faster than the mixture. Although government agencies may use hydrogen, which has greater lifting power, they do not do so because of the hazard involved. Two sizes of tanks were shown--a large one, size G costing $32, which will fill 40 to 50 of the 30-gram balloons or 15 to 20 of the 100-gram balloons, and a smaller one, size E costing about $9, which can be packed into the spraying location. Premarking of the area with balloons is generally not a good idea, for the balloons may be broken or tangled in the trees by winds, and heavy dew may put them down.

Smoke pots, smoke candles, and smoke pistols may have some value. Smoke pots give off a good smoke for 20 minutes. If the smoke drifts across the area to be sprayed, however, the pilot's visibility is obscured.

Plastic beach balls enclosed in a plastic bag have been used successfully on the top of several sections of television mast tubing. This tubing costs 20 cents per foot, plus additional expense for guy wire. With sufficient guying, a 50- to 60-foot mast may be erected. Small plastic pillows at $1.50 per dozen are also used on the masts in

the place of the beach balls. They are painted before using--usually red. Mirrors, such as are supplied in aircraft emergency kits for signalling, are another possibility, especially where the vegetation is not tall.

Previously deadened corner trees may also be used. These trees should be killed several weeks before the area is to be sprayed so that the dead foliage will show up prominently. In a recent trial the trees were frilled and an herbicide applied to the frill. Another possibility is to spray the boundaries of the area several weeks in advance to give a boundary of brown trees.

The pattern of flying to be used should be left to the discretion of the pilot. The two general patterns flown are the grid and the race-track. Some misses are probably inevitable, but in forestry work such misses are permissible in most cases. USDA Technical Bulletin No. 1110[3/] was mentioned as a good reference on spray-deposit patterns although its main purpose was to discuss spraying at low levels.

Argetsinger commented that balloons must be put up in the morning shortly before the spraying is to start. He has used antenna poles with flags, which were found to be good for at least ten setups at a cost of 62 cents per acre.

Powers said that no marking is needed for an easily distinguished area. He has flown areas which were marked with tinfoil or with cardboard boxes about 2 feet square covered with colored paper. Kennedy told of placing 2-foot boxes covered partly with tinfoil and colored paper on top of 20-foot poles.

Powers added that often the pilots will identify the location of spray swaths by natural landmarks such as tall trees.

Burkett and Jenkins stated that they were both experimenting with frilling and poisoning marker trees.

3/ Chamberlin, Joseph C., Getzendaner, Charles W., Hessig, Harold H., and others. Studies of airplane spray-deposit patterns at low flight levels. 45 pp., illus. May 1955.

Minimum Weather Conditions Suitable for Aerial Application of Herbicides

Lyle M. Argetsinger of Kimberly-Clark, Inc., who discussed the minimum weather conditions suitable for aerial spraying, said that 50 to 60 feet is the maximum height for application of herbicides, with lower levels more desirable. Trees should receive an application of spray on all sides, not just on one side, for effective kill. Spray should be applied at a time of the year when it will be absorbed by the plant, and with atmospheric conditions such that the spray will move toward the ground. A wind of six miles per hour is probably the maximum at which spraying should be attempted. A job should be ready to go at 3:00 a.m. and in the late afternoon when the thermal winds have died down and air movement is at a minimum. Turbulence at mid-day makes for dangerous flying conditions and will carry the chemical away. The effect, if any, of low or high temperatures is unknown. Spraying should not be done when rain is expected within 2 or 3 hours, or when the leaves are wet. However, one member of the group remarked that he saw no difference in areas sprayed in the rain from those sprayed in dry weather.

Powers added that wind makes for difficult spraying, especially when the brush areas contain scattered tall trees. On certain days, even when the air is still, there are times when the spray may "hang up." The pilot can tell by looking into the sun across the sprayed area when this is happening, but it is not visible to those on the ground. They should take the pilot's word for this, and the operations should be stopped until better conditions are obtained. In spraying, such as along rights-of-way, it should be remembered that spray will move outward on the curves.

Simulating Aerial Application in Herbicide Tests

Eugene I. Roe and R. E. Buckman of the Headwaters Research Center described and demonstrated equipment to simulate aerial application of herbicides on a milacre area. The following paper by Roe was submitted to describe the purpose and operation of the equipment:

> In brush control work done by foliage spraying with herbicides, widely varying amounts of solution have been used. These range from as much as 200 gallons per acre with power pumps down to 20 to 50 gallons for various back-pack pumps, and 2 to 5 gallons per acre for aerial application. Yet, with all of these volumes, results as measured by foliage kill of brush have been generally quite good.
>
> Since, of the low volumes applied from the air, the proportion reaching the ground may be only 1/2 to 2/3 of the solution leaving the nozzles, it would seem that the amount actually needed may be even less than the 2 to 5 gallons now being used. To find out just how much volume

of solution and also how much herbicide is required for the satisfactory control of brush of common species and densities, we have built a cage which will be used in the field to simulate low-volume application such as is used by planes.

Different herbicides will be applied at different strengths and volumes at fortnightly intervals throughout the growing season to our common brush species. The relative merit of the common carriers--oil and water--will also be studied.

The cage is 6.6 feet square and adjustable in height to 9 feet. It thus encloses a plot a thousandth acre in size. The sides are made of "screen-glass," detachable for portability, so as to prevent drift; the top will be left open.

The herbicide solutions will be applied through a system of overhead nozzles and forced from the line by compressed air much as in the system used by Professor Hansen of the University of Minnesota Forestry School in his studies of conifer tolerance to herbicides. The air is stored in a 400-pound tank, previously filled at an automobile service station, and is reduced to 30 or 40 pounds pressure by a special valve before it reaches the herbicide supply tank.

The nozzles being tested at the moment are Bete P-5 fog nozzles. These have an orifice of 0.005 inch and are rated at 1/4 gallon of water per hour each at 40 pounds pressure. However, they seem to be delivering quite a bit more than this. Once we have them properly calibrated, we will use time as a measure of volume application. For instance, to apply 2 gallons of solution per acre through a system of four nozzles with a 1/4-gallon-per-hour rating, the line would have to be open for 7 seconds at 40 pounds pressure. It was originally planned to measure out the actual applications intended. However, when we considered the small volumes involved (less than 4 cc. for a 1-gallon-per-acre application), we realized that these would do little more than wet the inside of our lines. We, therefore, have settled on time as a measure of the volumes applied.

Once the optimum volumes are worked out, the next step will be to design equipment and to work out aerial application techniques which will put these volumes on the foliage of the brush.

Demonstration of Spraying at Two Different Pressures

Following demonstration of the spray chamber, N. Powers of Mesaba Aviation gave a demonstration of spraying along the airport runway. A solution of ferric chloride was sprayed on paper previously impregnated with tannic acid; each droplet of spray left a black spot. The first pass was made with a pressure of 55 pounds in the system and the second at 30 pounds, both at a speed of about 75 miles per hour with the plane about 5 feet above the ground. At the same speed and height, the plane was calibrated to deliver 2 gallons per acre at 47 pounds pressure. The accompanying reproductions of the patterns obtained show the size and distribution of the droplets.

DESCRIPTION OF TEST AREAS VISITED

Stop No. 1

(Weideger farm; sprayed for Minnesota Division of Forestry)

Object : Low release from brush of jack pine machine-planted in spring 1952.

Brush : Sandbar and Bebb willows.

Treatment: Area, 33 acres; chemical, 1.5 pounds D-T (50-50 mixture of the propylene glycol butyl ether esters) in a 2-gallon oil-water emulsion per acre; partly replanted (machine) to jack pine in spring 1955.

Date : July 28, 1954; 5:00 to 8:00 a.m.

Weather : Wind, none; foggy; brush damp; heavy rain on 2 preceding days.

Location : Sec. 33, T. 52N., R. 25W.

Results : Good kill of brush; grass has greatly increased in density. Jack pine turned red and lost needles after spraying but has made good recovery.

Stop No. 2

(Weideger peat land area; sprayed for Minnesota Division of Forestry)

Object : Preplanting release of black spruce planting site.

Brush : Tag alder, willows, dogwood, raspberry, swamp honeysuckle.

Treatment: Area, 27 acres; chemical, 1.5 pounds D-T (50-50 mixture of the propylene glycol butyl ether esters) in a 2-gallon oil-water emulsion per acre; planting, hand-planted to black spruce seedlings and transplants in fall 1954 and spring 1955; also to white spruce transplants in spring 1955; a portion furrowed fall 1954 and hand-planted on furrow slice spring 1955.

Date : July 28, 1954; 5:00 to 8:00 a.m.

Weather : Wind, 2 mph; partly cloudy; brush damp; heavy rain on 2 preceding days.

Location : Sec. 2, T. 51N., R. 25W.

Results : Excellent kill of brush, but grass has greatly increased in density and height.

Stop No. 3

(Carlton plantation; sprayed for Northwest Paper Company)

Object : To release a 4-year-old plantation of jack and red pines from aspen suckers; machine-planted spring 1949.

Brush : Mostly trembling aspen suckers with some pin cherry, paper birch, alder, hazel, and willow.

Treatment: Area, about 5 acres in a strip about 3 chains wide; chemical, 1.6 pounds D-T (50-50 mixture of the propylene glycol butyl ether esters) in a 4-gallon water solution per acre; additional spraying was done here at 5:30 a.m., August 6, 1954, with 1½ pounds D-T (same ester formulation as 1953 spraying) in a 2-gallon diesel oil solution per acre. This job consisted of 5 acres of respray and 3 acres new spraying.

Date : July 28, 1953; 5:35 a.m.

Weather : Wind, 1 to 3 mph.

Location : N½ SE¼, Sec. 2, T. 48N., R. 17W.

Stop No. 3 (continued)

Results : Good release was noted after the first application. The second application was made to determine the effects of repeated spraying as well as to release an area not included in the initial spraying. Good release was also noted after the second spray. No appreciable damage to pines occurred as a result of the second application. However, extensive damage to jack pine was noted on the west edge where only one application was made. This damage, which is the result of an over-dosage of spray (repeat flights over the same strip), points up the need for proper ground control.

Stop No. 4

(Holyoke area; sprayed for Northwest Paper Company)

Object : High release of planted red pine.

Brush : Northern pin and red oaks up to 30 feet in height.

Treatment: Area, 70 acres; chemical, 1.5 pounds D-T (50-50 mixture of the propylene glycol butyl ether esters) in a 2-gallon diesel oil solution per acre; marking, red flags on bamboo poles erected in trees.

Date : August 6, 1954; 6:00 a.m.

Weather : Wind, 0 to 5 mph.

Location : Sec. 27, T. 46N., R. 17W.

Results : Excellent kill of oak with only a little resprouting along branches; no further release will likely be needed.

Stop No. 5

(Babbitt site-preparation spraying for Superior National Forest, Lake States Forest Experiment Station cooperating)

Object : Preplanting release of upland planting site where original plantation following the logging had failed because of deer browsing.

Brush : Hazel, upland and tag alders, mountain maple, aspen suckers, with some dogwood, cherries, and raspberry.

Stop No. 5 (continued)

Treatment: Area, 20 acres; chemical, 2 pounds D-T (50-50 mixture of the propylene glycol butyl ether esters) in a 4-gallon oil-water emulsion per acre; applied by two planes making separate flights over the plot, one flying east to west, the other from west to east; planting, area was hand-planted to 1-2 red pine and 2-2 white spruce in bands of 4 to 5 rows each on May 7-8, 1955.

Date : July 30, 1954; 7:00 to 7:40 a.m.

Weather : Wind, 0 to 2 mph; clouding up; brush wet with heavy dew; no rain for at least 10 hours after spraying.

Location : Sec. 1, T. 59N., R. 12W.

Results : Planting made much easier by the excellent job of killing back the brush.

Stop No. 6

(Highway No. 2, natural-conifer release and planting-site preparation; sprayed for Kimberly-Clark of Minnesota, Inc.)

Object : To kill brush and groups of cull hardwoods for release of natural balsam and to prepare area for planting spruce.

Brush : Alder, mountain maple, hazel, willow, raspberry, paper birch.

Treatment: Area, Plots B and C, 20 acres each; chemical, Plot B, 1 pound D (propylene glycol butyl ether ester) in a 2-gallon oil-water emulsion per acre; Plot C, 1 pound D-T (50-50 mixture of the propylene glycol butyl ether esters) in a 2-gallon oil-water emulsion per acre.

Date : Plot B--July 1, 1954; 6:20 to 7:00 p.m.
Plot C--July 1, 1954; 7:30 to 8:00 p.m.

Weather : Plot B--Fair; wind, 3 to 8 mph with increasing gusts; air cool; temperature approximately 60°; sky overcast; light rain showers within 24-hour period before application.
Plot C--Same as Plot B.

Location : Sec. 31, T. 57N., R. 10W., 1/2 mile south of Toimi Road on Highway No. 2.

Stop No. 6 (continued)

Results : Plot B--Good kill on alder, hazel, and mountain maple; no appreciable effect on raspberry; fair to good kill or damage of birch. Should result in effective release. Raspberry, ribes, grasses, and herbaceous growth spreading rapidly under killed brush.

Plot C--Good kill or serious damage to all major species; release of conifers should result. Rapid increase in grass and herbaceous cover taking place.

Stop No. 7

(Stony River natural-conifer release; sprayed for Kimberly-Clark of Minn., Inc.)

Object : To kill back cull hardwoods and tall brush for release of natural seedlings, saplings, and small trees (up to 30 feet in height) of balsam fir, white spruce, and black spruce.

Brush : Paper birch, aspen, mountain maple, tag alder, hazel, dogwood.

Treatment: Area, Plots H and I, 20 acres each; chemical, Plot H, 2 pounds D-T (50-50 mixture of the propylene glycol butyl ether esters) in a 4-gallon oil-water emulsion per acre; put on in two flights applying 2 gallons each; both flights made in same direction, west to east, because of topography. Plot I, 1 pound 2,4,5-TP (Kuron) in a 4-gallon oil-water emulsion per acre and applied as on Plot H.

Date : Plot H--July 7, 1954; 6:00 to 7:30 a.m.
Plot I--July 2, 1954; 8:00 to 9:30 a.m.

Weather : Plot H--Wind, none; air warm and dry; no rain for 5 days previous to application.

Plot I--Wind, 6 to 8 mph with higher gusts; air cool, humidity high; sky overcast; heavy showers 12 hours before application.

Location : Sec. 24, T. 59N., R. 10W., 4 miles south of Stony River bridge.

Results : Plot H--Brush kill somewhat variable, generally good in openings and under light hardwood cover. Release of balsam and conifers probably effective on most of area; kill of birch good, and of aspen variable but generally poor; heavy invasion of grasses and herbaceous vegetation under previously heavy brush cover.

Plot I--Results variable; fair to good kill on birch and on mountain maple and hazel in openings; heavy ingrowth of grasses and herbaceous plants where brush kill was good.

Stop No. 8

(Finland natural-conifer release; sprayed for Kimberly-Clark of Minn., Inc.)

Object :	To kill back cull hardwoods and dense tall brush for release of natural seedlings and saplings (up to 6 feet in height) of balsam fir, white spruce, and black spruce.
Brush :	Paper birch, balsam poplar, aspen, mountain maple, tag alder, hazel, raspberry, pin cherry, and chokecherry.
Treatment:	Area, Plots F and G, 20 acres each; chemical, Plot F, 1 pound 2,4,5-TP (Kuron) in a 4-gallon oil-water emulsion per acre, put on in 2 flights applying 2 gallons each; both flights made in same direction, north to south, because of topography. Plot G, 1 pound T (propylene glycol butyl ether ester) in a 4-gallon oil-water emulsion per acre; put on in 2 flights of 2 gallons each as on Plot F.
Date :	Plot F--June 30, 1954; 5:30 to 7:00 a.m. Plot G--July 7, 1954; 5:30 to 7:00 a.m.
Weather :	Plot F--Very calm; fair; brush wet from previous afternoon's rain. Plot G--Light easterly wind to 8 mph, gusty; considerable drift; sky clear; air warm; low humidity; no rain for 5 days previous to spraying.
Location :	Sec. 1 and 2, T. 57N., R. 8W., 3 miles north of Finland on State Highway No. 1.
Results :	Plot F--Results variable; generally poor to fair with frequent spots of only light kill and damage to all broadleaf species. Plot G--Fair to good kill on alder and hazel; results variable on other species.

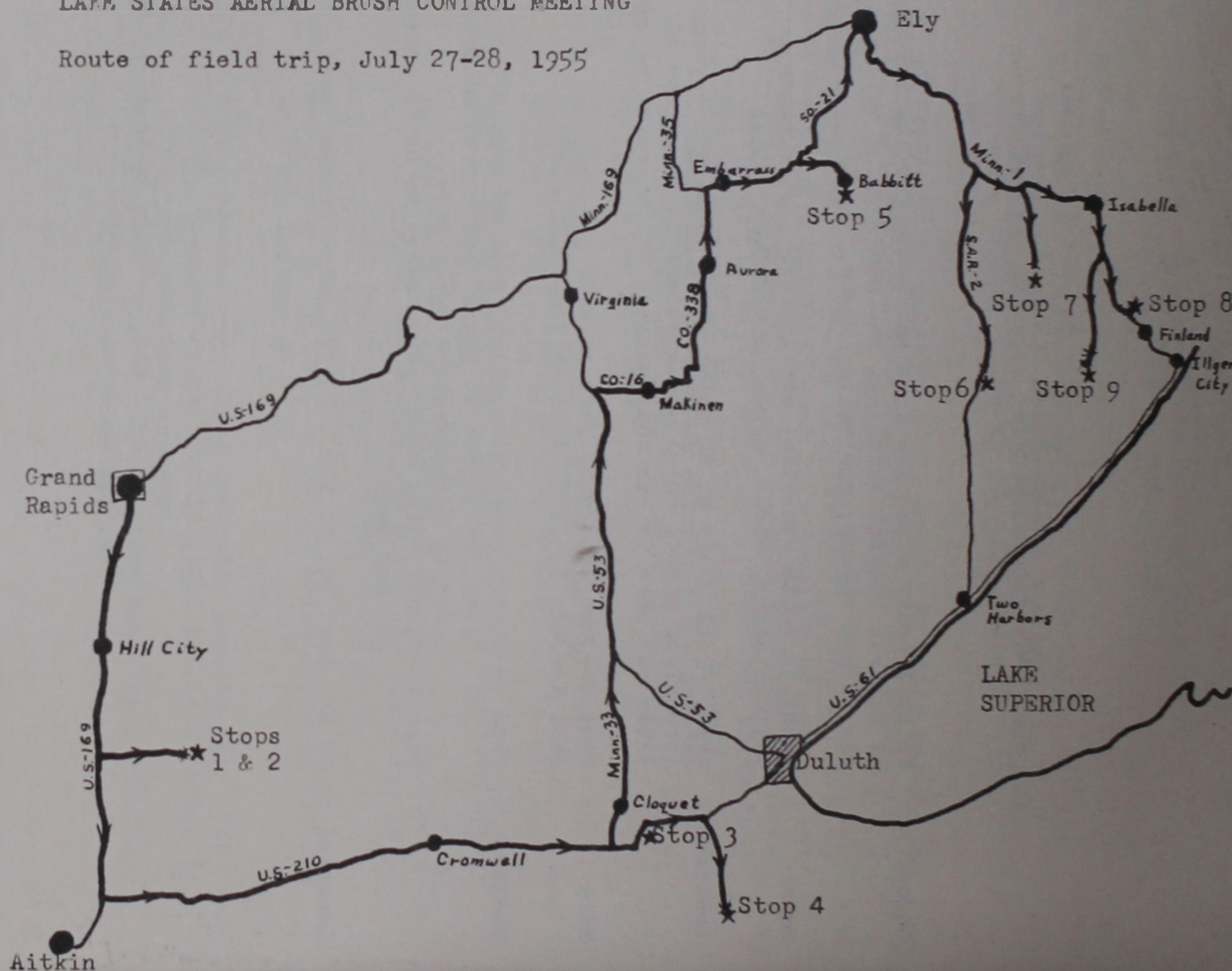
Stop No. 9

(Cloquet Lake natural-conifer release; sprayed for Kimberly-Clark of Minn., Inc.)

Object :	To kill heavy brush and cull hardwoods for the release of natural conifer seedlings and saplings of balsam fir, black spruce, and white spruce.
Brush :	Mountain maple and hazel particularly, plus cherry, willow, alder, birch, aspen, and balsam poplar.
Treatment:	Area, Plots J and K, 40 acres each; chemical, 1 pound T (propylene glycol butyl ether ester) in 4 gallons of water per acre in one application, flying south to north.
Date :	Plot J--June 14, 1955; 7:00 to 8:00 p.m. Plot K--July 5, 1955; 5:00 to 7:00 p.m.
Weather :	Plot J--Clear; cool; very slight wind at tree crown level, NW to SE; 24 hours' clear weather preceded by 6 consecutive rainy days. Plot K--Clear; warm; wind, none; heavy rains on previous day and week.
Location :	SW NW, Sec. 10, T. 57N., R. 9W., near Cloquet Lake.

LAKE STATES AERIAL BRUSH CONTROL MEETING

Route of field trip, July 27-28, 1955



ATTENDANCE AT MEETING

American Chemical Paint Co.: L. W. Melander, St. Paul, Minnesota
Blandin Paper Co.: L. J. Pulkrabe, Grand Rapids, Minnesota
Chequamegon National Forest: H. C. Jacobs and W. R. Paddock, Park Falls, Wisconsin
Chippewa National Forest: P. J. Fassett, Louis C. Hermel, and J. R. Seward, Cass Lake, Minnesota; W. R. Isaacson, Bena, Minnesota; and J. N. Licke, Walker, Minnesota
Consolidated Water Power & Paper Co.: J. W. Macon, Rhinelander, Wisconsin
Dairyland Electric Cooperative: Walter R. Smith, Grand Rapids, Minnesota
Division of State & Private Forestry: L. B. Ritter, St. Paul, Minnesota
Dow Chemical Co.: R. L. Warden, Minneapolis, Minnesota; and L. L. Coulter, Midland, Michigan
Fjosling Sprayers: Harold Fjosling, Elbow Lake, Minnesota
Halvorson Trees: John Hamilton, Duluth, Minnesota
Headwaters Research Center: R. E. Buckman, M. L. Heinselman, A. W. Krumbach, E. I. Roe, and Z. A. Zasada, Grand Rapids, Minnesota
Iron Range Resources & Rehabilitation Commission: Bernard Granum and Ed Haslerud, Hibbing, Minnesota; and Jerome M. Heinz and William J. Sliney, Park Rapids, Minnesota
Kimberly-Clark of Mich., Inc.: Lyle Argetsinger, Neenah, Wisconsin
Kimberly-Clark of Minn., Inc.: P. Huntley, Neil McKenna, Dixon Sandberg, and Kenneth Torgerson, Duluth, Minnesota
Lake States Forest Experiment Station: J. L. Bean, R. D. McCulley, and R. F. Watt, St. Paul, Minnesota
Longlac Pulp and Paper Co., Ltd.: E. R. Humphreys, Longlac, Ontario, Canada
Lower Peninsula Research Center: John L. Arend, East Lansing, Michigan
Marathon Corporation: Asa Allhiser, Rothschild, Wisconsin
Mesaba Aviation: Gordon K. Newstrom and N. Powers, Grand Rapids, Minnesota
Michigan Conservation Department: B. C. Jenkins and Glenn M. Schaap, Lansing
Minnesota & Ontario Paper Co.: F. T. Frederickson, E. E. Laitala, and R. J. McDevitt, International Falls, Minnesota; A. F. Ennis and John W. Hubbard, Big Falls, Minnesota; and R. A. Olson and M. J. Plummer, Effie, Minnesota
Minnesota County Agencies: Floyd Colburn, Extension Forester; Art Frick, County Agent; C. H. Godfrey, Itasca County Land Commissioner; and William Marshall, County Forester; Grand Rapids

Minnesota Conservation Department: Earl J. Adams and Joseph Gorence, St. Paul; E. W. Simons and V. E. Gunvalson, Bemidji; Milton H. Stenlund, Ely; B. C. Ahlm, A. K. Anderson, R. L. Knox, M. J. Latimer, and Frank Usenik, Grand Rapids; M. A. Rhodes, Hibbing; George Gaylord, R. J. Kennedy, and W. R. Schmechel, Hill City; N. W. Woollett, Moose Lake; William F. Olson and Sidney Rommel, Park Rapids; Willard E. West, Warroad; and John K. Childs and J. Donald Meyer, Willow River

Mosinee Paper Co.: T. F. Michal, Solon Springs, Wisconsin

Nekoosa-Edwards Paper Co.: B. Berklund and Robert C. Dosen, Port Edwards, Wisconsin

Nicolet National Forest: Luther B. Burkett, Rhinelander, Wisconsin

Northern Lakes Research Center: R. A. Ralston, Wausau, Wisconsin

Northwest Paper Co.: E. J. Jankowski, Cloquet, Minnesota

Ontario Paper Co.: R. S. B. Miller, Heron Bay, So. Ontario, Canada

Pulp & Paper Research Institute of Canada: Gordon Weetman, Montreal, Quebec

Regional Office, U. S. Forest Service: John K. Kroeber, Merle S. Lowden, and William L. Robb, Milwaukee, Wisconsin

Sorenson Manufacturing Co.: Eldon Sorenson, Worthington, Minnesota

Superior National Forest: David N. Kee and Stanley B. Olson, Duluth, Minnesota; August E. Block, Ely, Minnesota; and Donald H. Ferguson, Two Harbors, Minnesota

Triangle Aviation, Inc.: M. O. Manuel, Stanton, Minnesota

U. S. Bureau of Indian Affairs: L. W. Chisholm, Bemidji, Minnesota; C. T. Eggen, Minneapolis, Minnesota; Charles H. Racey, Ashland, Wisconsin; and W. J. Ridlington, Shawano, Wisconsin

U. S. Fish and Wildlife Service: J. M. Coutts, Minneapolis, Minnesota

University of Minnesota, School of Forestry: B. A. Brown, O. F. Hall, and Henry L. Hansen, St. Paul, Minnesota; R. A. Jensen, Cloquet, Minnesota

West Central Airways: Joe Devorak, Fergus Falls, Minnesota

Wisconsin Conservation Department: George F. Hartman, Black River Falls; D. J. Mackie, Boulder Junction; Joseph F. Zagorski, Brule; A. J. Lupa, Gordon; and L. W. Lembcke, Tomahawk

SOME RECENT STATION PUBLICATIONS

Anderson, R. L., and Skilling, D. D.
Oak wilt damage, a survey in central Wisconsin. Lake States Forest Expt. Sta., Sta. Paper 33, 11 pp., illus. July 1955. (Processed.)

Arend, John L.
Chemical frill girdling in summer and fall gives best results in Lower Michigan. Lake States Forest Expt. Sta., Tech. Note 438, 1 p. July 1955. (Processed.)

Dickerman, M. B.
The changing forests of the Lake and Central States region. Lake States Forest Expt. Sta., Misc. Rept. 31, 10 pp. October 1954. (Processed.)

Guilkey, Paul C., Granum, Bernard, and Cunningham, R. N.
Forest statistics for Minnesota, 1953. Lake States Forest Expt. Sta., Sta. Paper 31, 36 pp., illus. November 1954. (Processed.)

Heinselman, M. L., and Zasada, Z. A.
A review of literature relating to quaking aspen sites. Lake States Forest Expt. Sta. and Office of Iron Range Resources and Rehabilitation, Sta. Paper 32, 61 pp. May 1955. (Processed.)

Horn, A. G.
Cut of veneer logs increases in Minnesota, decreases in Wisconsin and Michigan, 1954. Lake States Forest Expt. Sta., Tech. Note 442, 2 pp. October 1955. (Processed.)

Roe, E. I.
Forest plantation release; what it is--how to do it. Lake States Forest Expt. Sta., Misc. Rept. 33, 29 pp., illus. January 1955. (Processed.)

Rudolf, Paul O.
Tree races and forest tree improvement. Lake States Forest Expt. Sta., Misc. Rept. 35, 8 pp. February 1955. (Processed.)

Scholz, H. F., and Hovind, James
Effect of the micro-site on the condition and early growth of planted black spruce. Lake States Forest Expt. Sta., Tech. Note 434, 2 pp. July 1955. (Processed.)